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EDITORIAL

Electronic publishing in science: changes and risks

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The Internet has revolutionized data transfer and use. It makes a host of world-wide information quickly available in offices or homes — at finger tip control. The concept of the graphical component of the Internet, the World Wide Web, was first envisioned and then developed in the early 90s by Tim Berners-Lee. His ideas advanced to practicable reality when the US Government began to finance the Internet. Since 1994 the Net has been guided by the World Wide Web Consortium (W3C)[1]. Directed by Berners-Lee, the W3C works out recommendations, not rules. Nevertheless, the Consortium commands great authority, and large firms such as Microsoft and Netscape accept its recommendations as guidelines for developing their products. The growing powers of Berners-Lee have recently incited opposition. The credo is: 'no kings!' While some firms have ended their cooperation with the W3C, most Internet supporters want the Consortium to continue organizing Net structure and data flow — but to abstain from attempts at regulating or governing the Internet. In essence, then, the Internet is a giant with a powerful body but without a head.

The Internet is growing explosively and is affecting many aspects of the human world. At present we can neither fully assess the extent of the resulting changes nor their consequences. With respect to science, three things are certain, however: (1) There will be no principal changes in the ways knowledge is created, quality-controlled and utilized by researchers. (2) There will be significant changes in the ways scientists communicate with each other, in which research results are presented, and in which knowlege is analyzed, disseminated, and digested. (3) There will be risks that endanger science as we know it today.

The principles governing the processes of creating, testing and utilizing scientific knowledge have ancient roots and a long history. Principles and history mirror the capacities and ways of our brains to investigate and understand the world in and around us. While need for improvement persists, the essentials have stood the test of time and allow only limited scope for change. In contrast, the scope is large for inventing and applying new technologies that improve the presentation and analysis of knowledge and that provide better access to it. It is here that electronic technologies can significantly change the scientific scene.

In a keynote lecture delivered at the Fifth International Conference of Scientific Editors I described and analyzed the scholarly scientific process (Kinne 1988). It comprises production, quality control, dissemination and consumption of knowledge, and it is represented by authors, editors, referees, publishers and users. New knowledge is obtained by applying universally accepted formalized procedures. It is evaluated, quality-improved, published, compared to and tested against existing information, and used for further search for truth and/or practical application. My lecture focussed on the performances of the 5 components, their potentially diverging interests, and on possibilities of controlling and reducing interest conflicts. In this editorial I consider the impact on science of new ways of publishing, primarily with a view on ecology and biology.

Reliable, quality-controlled scholarly scientific information, presented in papers published in academic journals, is the substrate and prerequisite for orderly communication among scientists, for advancement in science, and for planning and organizing the future of humanity. Hardly any scientist is likely to contradict this statement. If most of us agree, where is the problem? It has to do with the rapidly growing mass of new knowledge, the insufficient speed and the increasing cost of publishing it, as well as with its accessibility, retrievability and storage in libraries, laboratories or on the desks of scientists. Strangely, the increasing cost of

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[1]Decision makers: Scientists and managers; members: firms, non-profit organizations and governmental agencies from around the world; operation basis: Massachusetts Institute of Technology, Boston, USA

producing the scientific knowledge (more scientists, more universities, additional research facilities, new equipment, etc.) provoke less criticism than the increasing cost of publishing the endproduct of it all: the manuscript.

Critics have made out the black sheep: science publishers. They are accused of hanging on too firmly to traditional print-on-paper techniques, of being too slow and ineffective in making knowledge available, and of charging overrated prices. New methods of publication are practised and new means of digesting the gigantic information soup. Not only the black sheep have been identified, also the medicine for curing the traditional publication system: electronic publishing.

CHANGES

Electronic publishing brings us a host of changes. It increases the speed of communicating, disseminating and digesting knowledge. It provides new means of searching for, finding and analyzing specific information. It reduces the need for additional shelf capacities in libraries. Yes, electronic publishing can not only trim the publication process, it can also make it cheaper. All this is good for science and may increase the competition between publishers — a desirable feature for correcting overrated publication costs. 'A shake-out of the entire scholarly publishing industry seems inevitable' (Butler 1999, p. 195).

Let us consider some of these points, especially speed and cost, in more detail.

(1) Speed

How much can electronic publishing increase the speed of publication? The time span between manuscript (ms) receipt and acceptance is determined by the length of the review process. In 'Marine Ecology Progress Series' (MEPS) we send received mss to 4 or more (up to 6) reviewers. The reviewed ms is returned to the authors, together with copies of the reviewers' reports (without revealing their names). Unless the ms is rejected at this stage, we invite the authors to consider, accomodate or convincingly refute the reviewer's comments and criticisms. Usually it takes the authors weeks or months to revise their work. The revision is again examined by reviewers (not necessarily the same ones). Depending on their recommendations, about 60% of the revisions are sent again to the authors for additional quality improvements. Sometimes this process must be repeated. As much as possible we communicate with the authors by e-mail or fax. When the editor finally accepts a ms, it is copy-edited (our copy editors are professionals; the high quality of their work is widely acknowledged), typeset (also done by carefully trained in-house personnel) and the result returned to the authors for examination. There is no way of reducing the time span between ms receipt and acceptance without losses in quality.

Quality, however, is the heart of the scientific process and of the success of MEPS — the reason that this journal ranks world-wide as the Number 1 in its field, and that most marine ecologists consider it their first choice as publication outlet. Even if a ms is rejected at a later stage of the review process, the authors benefit from the comments and criticisms of MEPS reviewers; they can improve their work accordingly and thus increase the chances of acceptance by another journal.

It usually takes the authors weeks to return their proofs. These are print-readied within a few days. Printing and binding take on average only 1 or 2 weeks: this is the time span that could be saved if MEPS went electronic — plus mailing time. MEPS plans to eventually have an electronic double. This would not pose technical problems but we prefer to examine the situation carefully before making a decision. In questionaires sent out in 1998 to about 100 top performers in marine ecology, of 79 returners only 2 considered such a step urgent. Please consider the present situation: the titles of selected papers appear in MEPS' Internet pages (under 'forthcoming papers') as soon as the ms is accepted; abstracts (with searchable texts) are published on the Net the day the paper versions appear. Anyone interested can request a copy of the full paper at a relatively low cost by mail, fax, or e-mail — in the latter two cases often a matter of hours.

To speed up review procedures, some colleagues have called for direct contacts between authors and reviewers; they favor an 'open review process'. Obviously, they are aware neither of the resulting conflict potential nor of the difficulties in finding good, reliable reviewers — the cream of quality control — willing to put their own work aside in order to help others, sometimes even competitors. Reviewers deserve a big pat on the shoulder. Whether or not to reveal their names to authors must be left to their discretion. Personally, I cannot see benefits for science in opening up the review process, except in rather special cases in which direct contacts between author and reviewer are considered necessary by both.

Most scientists seem to be concerned about the growing mass and questionable quality of information rather than about the speed at which new information reaches them. Do we overestimate the significance of speed? The limits of information consumption are set by human, not technological, capacities. Some enthusiasts sit all day and part of the night in front of their

computer, but scientists who want to survive professionally must spend most of their time doing research!

I have asked many colleagues where they do their literature reading. Most of them answered 'in bed'. But who wants to go to bed with a computer? Books and journals were pronounced dying decades ago. They are still very much alive and I am confident they will stay that way. There is a place and a need for both: print-on-paper *and* electronic publishing.

(2) Cost

Electronic publishing eliminates the costs of printing, binding and posting. But it will never be free — as advertised by some e-publication pioneers.

Who knows what access to and use of the Internet will cost 5 or 10 years from now, especially if privatization proceeds? Who can expect that the work of editors and referees will continue to be had for 'free'? In fact, it has never been free. It has been paid for by sources outside the publishing process: mostly by their employers. Will this continue? Several universities and research institutions are not very happy about this practise, even though they recognize that appointment of their staff to editor or reviewer of a renowned journal documents professional distinction and that part of such distinction extends to the home institution.

As I see it, editors and reviewers will increasingly demand some sort of compensation from the publisher, the more so, should they be asked to perform outside their normal working hours. At MEPS we go some way towards compensation: We publish the names of our staff reviewers, who process per person and month on average 1 or 2 mss, and make free copies available to them. At 15 volumes per year this amounts to an annual sales value plus postage of some DM 5000 (US$ 2728) per person, i.e. about DM 500000 ($ 272776) for the ca 100 editorial staff. In order to estimate the total annual costs for personnel, the salaries of our technical staff must be added: about DM 1 million (ca $ 545554). These expenses are only part of the total fixed costs. Except for printing, binding and posting the fixed costs remain the same whether MEPS appears print-on-paper or electronic.

Quality has its price! Nevertheless, in the Journal Price Study (1998) which surveyes a total of 314 journals, the costs for MEPS range in the mid field of core biological titles.

Professional copy-editors whose mother tongue is English and who are sufficiently familiar with the authors' scientific field are indispensable if a journal is to achieve a high international standing. In addition to their usual work they assist authors from non-English speaking countries in spelling, grammar and linguistic formulation. Without such assistance numerous authors would be excluded from leading publication outlets. Our MEPS copy-editors spend much of their time in helping these colleagues.

I have heard of on-line operators who plan to cover their costs by cashing in on authors: $ 50 to 100 for peer review, some additional $ 300 to 500 upon ms acceptance and publication. This is a *shift* of costs, above all an undemocratic one. It would make science publication a matter for the rich, excluding thousands of scientists who cannot raise such funds.

As yet insufficiently tapped possibilities for reducing publication cost lie in cutting down on wordiness and jargon, by insisting on concise writing. Large parts of a typical ms repeat known information or dwell on not immediately relevant facts. University staff, research group leaders, editors, referees and copy-editors are called upon to improve the situation. Reductions in publication cost may also be expected due to technological advances in printing and binding.

To my knowledge, for a typical library, journal subscription costs amount to only about one third of the total expenses, the major part of the budget being eaten up by overhead, staff, equipment, storage facilities and building activities. Where libraries must no longer grow in size, savings in total expenses become possible. Many scientists agree that electronic publishing will change the operation patterns of libraries. There even are experts who question the need for the continued existence of libraries altogether: 'if you can call up any paper on your screen, and after deciding that it looks interesting, print it out on the laser printer on your desktop, will you need a library?' (Odlyzko 1994, unpag.). I do not believe that libraries will disappear. They will lose some of their importance as places to go for new information, but in the innumerable pages they own, libraries command a wealth of ordered published information. They may also develop new activities. 'Librarians, along with publishers, have traditionally been entrusted with the responsibility to make order out of scholarly chaos.' (Stix 1994, p. 76). Equally, traditional publishers will not disappear, as several promoters of e-publishing predict. They will make their print-on-paper journals available also on the Internet. Many of them have done this already, others are planning to do it. In such cases there may be no loss in scientific quality. Users may consult the publisher's Internet pages around the clock and digest screened, solid information in the lab or at home.

Commercial journals can not enjoy cost subsidization by member fees as can society journals. Hence the latter are cheaper, certainly to members. Where such societies have many members, this will also affect impact factors. Society members usually have their journal within reach, hence they are likely to quote

from it more frequently than from less accessible journals. Nevertheless, a look at lists of published impact factors reveals that commercial journals tend to have higher ratings.

Very costly commercial journals face not only increasing criticism but also counteractive measures. Thus, the US Association of Research Libraries has decided to support new journals that compete with expensive titles. Reportedly, with its more than 100 member libraries the Association has pledged to buy each of them. What if the new journals receive insufficient numbers of good manuscripts or low impact ratings, or both? And what about free market rules? Can you really create good, competitive low-cost journals simply by assuring the operators that, provided they challenge high-priced journals, you will buy their products? Most libraries live on taxpayers' money. They may be held responsible if they use that money for purposes other than those it was given for. Is competition for price so much more important than competion for performance? We must explore better means for the justified fight against overrated publication costs.

An impressive case of rebellion against overrated publisher prices is 'the recent decision by Michael Rosenzweig ... to defect, along with the entire editorial board, from the Wolters Kluwer Journal 'Evolutionary Ecology Research'. Rosenzweig had become disenchanted with price increases at the journal which he established 12 years ago.' (Butler 1999, p. 197).

RISKS

The scientific process will be damaged where quality submits to quantity, where speed overrules exactness and performance, where we abandon time-tested controls. Computers are not only great in producing progress, they are also great in producing trash.

The scientific process abounds with risks of becoming blurred and distorted: neglect of copyright, intellectual property, scientific correctness and honesty; falsification of priority claims; concealed plagiarism or downright stealing of foreign findings and ideas; inappropriate application of scientific techniques and statistical methods; misquotations and misinterpretations of the works of peers; misspellings and misuse of scientific names and of taxonomic rules. In an overall scenario of increasing competition for jobs and professional standing, the pressure to publish and to perform grows, and with it grow numerous temptations. These offer themselves, more conveniently than anywhere else, in insufficiently controlled electronic publishing.

E-publishing injects fresh blood into publication processes, but where it lacks appropriate controls it is also conducive to new diseases — potentially more dangerous to science than the old ones — unless we observe and treat the patient with great care! The roles of editors and reviewers in protecting and guiding the scientific process were never more important than they are now, in the beginning age of electronic publishing.

'Internet evangelists who view the network as the ultimate equalizer for dismantling hierarchy' (Stix 1994, p. 75) are bound to fail. As witnessed by human history, equalization attempts have always failed. Why? Because competitive diversity is the very life blood of nature (and human culture). Science has relied on hierarchies and it must continue to do that. Top figures in the hierarchy must help to rescue authors from getting buried in an avalanche of unscreened information — not least on the Internet. Hierarchies in science are continously built and rebuilt, both at the individual level, and at the level of journals (impact factor ratings). In other fields of human activity too, hierarchies are established and challenged daily, for example in politics, entertainment and sports. How about 'equalizing' players in a football game? Internet evangelists do not promote electronic publishing in science, they undermine and discredit it.

The Internet offers excellent new opportunities for speedy *informal* exchanges of information among scientists, for discussing theories and hypotheses, for presenting brand new ideas to peers, for igniting creativity and innovation, for collaboration and cooperation, etc. These wonderful opportunities fertilize, but do not replace, quality-controlled *formal* publishing. We should never allow anyone to blur the line between informal and formal parts of the scientific process.

Examples of speedy low-cost publications are the e-(pre)prints of Paul Ginsparg, a high-energy theoretical physicist at Los Alamos National Laboratory, New Mexico, USA. His system is tailor-made for high-energy physics. It quickly became a main highway for communicating research data in theoretical physics. Ginsparg now serves thousands of users from 60 or more countries and processes many thousands of messages per day. His approach marks a major breakthrough in information sharing. Unfortunately, it fails to address copyright, 'one of the most nettlesome problems in electronic publication' and gives 'a misleadingly rosy impression' of electronic publishing benefits (Leslie 1995 unpag.). If Ginsparg's system included quality control, speed would significantly decrease and costs rise. The real expenses of his system will become apparent only if all costs are laid open, including those presently paid by the Los Alamos National Laboratory and those covered by Ginsparg's (and his helpers') salary. In reality, 'the preprint system ... is expensive, with some institutions paying as much as $20000 a year to copy and mail preprints'; it is also

'undemocratic, since only those scientists 'in the loop' of mailing lists receive the preprints' (Leslie 1995 unpag.).

Electronic publishing per se does not automatically affect scientific quality. This depends first of all on scientific performance and control, not on publication technologies. The risks begin where quality safeguards are abandoned or diminished, for example, where authors publish their papers directly and unscreened, where preprints prevail or continuous updating of published works. Unrefereed and/or unedited publishing is supported by some authors in an attempt to increase speed, reduce cost and facilitate dissemination (also in the hope of circumventing referee criticism and unpleasant editorial decisions?). Here thrives the murky soup of blurred information. Continuous updating is a normal process in science. Its place is not formally published articles (these must remain untouched for correct assessments of the authors' accomplishments, literature analysis and documentation), but informal publishings, discussions, meetings, and — above all — reviews, books or handbooks. The latter three are works of lasting value, documenting what we know or not know, how science has developed (been 'updated') and where it might go to in the future.

Is electronic publishing safe? I do not know. But I know that even the remotest possibility of unauthorized modification of electronically published data will endanger its creditability, and that the first case of uncontrolled post-publication change will discredit this new medium as an alternative to formal print-on-paper publishing. If computer specialists manage to unlawfully enter the 'holy' electronic spheres of the Pentagon and crack safety barriers of banks, can we be sure that they will not — for whatever reason — falsify published scientific data? Science, however, can function properly only if we can definitely exclude such potential abuse, as well as any other source of post-publishing distortion, if we can know exactly what a given author has published where and at what date — and if his/her writings are protectable, archivable and retrievable over long stretches of time.

CONCLUSIONS

Electronic publishing increases the speed of information transfer and decreases the costs of publication. It vastly improves traditional means for disseminating, exchanging and retrieving information. It facilitates contacts, discussions and cooperation among scientists, and it may lead to increased competition among publishers. All this is good for the scientific process.

Some pros of electronic publishing in science have been overestimated, some risks underestimated. It will take more time for final judgements. In any case, electronic publishing is unlikely to change the basic patterns of established science journals in the near future. It is even more unlikely to completely replace print-on-paper techniques. There is a need and a place for both.

If we study the risks with great care, manage to develop and install adequate safeguards, and if we hold on to time-tested quality controls electronic publishing can significantly benefit science.

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